Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
	Aluminide Coatings for Power-Generation Applications	4000032193	05/10/41	03/31/07

Performer Name and Address	Principal Investigator(s)
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BUDGET AND COST REPORT

Prior Year Funds [$K]	40
Total Current Year Commitment $K]	0
Projected Current Year Costs [$K]	78

	O	N	D	J	F	M	A	M	J	J	A	S
Planned Costs	2	6	12	15	25	35	40	47	60	73	76	78
Actual Costs	2	6	11	12	13	17						
Variance	0	0	1	3	12	18	40	47	60	73	76	78

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
TTU-2-1	Task I. Aluminide Coatings on Fe-based Alloys	09/30/05		
	• To set up a laboratory pack cementation system at TTU to coat relatively large specimens for testing in power-generation environment			
	• To compare the oxidation and/or corrosion performance of the pack coatings with the aluminide coatings made by chemical vapor deposition (CVD)			
TTU-2-2	Task II. Aluminide Coatings on Ni-based Superalloys	09/30/05		
	• To investigate the oxidation performance and rumpling behavior of the Pt-enriched gamma + gamma prime coatings on single-crystal superalloys			
	• To synthesize NiAl and/or (Ni,Pt)Al coatings modified with reactive elements such as hafnium by pack cementation using different doping approaches			

TECHNICAL HIGHLIGHTS

Task I – Aluminide Coatings on Fe-Based Alloys

• Thermodynamic calculations were conducted for pack aluminizing processes (with and without reactive element doping) using commercial software HSC Chemistry 5.0

In the process of synthesizing aluminide (or modified aluminide) coatings by pack cementation, the element to be deposited on the substrate is dependent on its halide partial pressure in the pack. In the past, commercial thermodynamic software packages, such as SOLGAS, SOLGASMIX, ITSOL, Chemsage, and HSC Chemistry, have been developed for calculations of the equilibrium partial pressure of each species (or the equilibrium composition) in various systems. The present study focused on calculating the equilibrium partial pressure of gas species in a typical pack cementation aluminizing process using HSC Chemistry 5.0. The results were compared with those published in the literature calculated by using other thermodynamic software. HSC Chemistry has the capabilities including calculations of mass balances, enthalpy balances, and phase equilibria in multicomponent multiphase systems. The major advantage of HSC, as compared to some other software program such as Chemsage, is its affordable price and an included database of over 16,000 compounds. In this study, totally 65 different packs selected from the literature were evaluated. The results indicate that HSC yielded similar results for the most pack compositions, while some discrepancy existed, particularly for the partial pressure of CrCl2. The difference might be caused by the different database provided in different software packages (e.g., the species included and their thermodynamic properties).

In addition, in order to explore possible routes to incorporate reactive element such as Hf in the aluminide coatings (on both Fe-based alloys and Ni-base superalloys), HSC was used to assess the equilibrium partial pressure of hafnium chlorides, assuming pure Hf, HfO2, and HfCl4 were added to the pack. From thermodynamic point of view, for co-deposition of Hf and Al, the partial pressure of hafnium chlorides should be within approximately two orders of aluminum chlorides. The calculation results suggest that it is possible to dope Hf into aluminide coatings by using Hf, HfO2, or HfCl4-containing pack.

Task II – Aluminide Coatings on Ni-Based Superalloys

• The oxidation results of the Pt-enriched g+g' two-phase coatings were summarized and were presented at the TMS Annual Meeting and Exhibition, San Francisco, CA, February 13-17, 2005.

• A manuscript entitled “A Platinum-Enriched g+g' Two-Phase Bond Coat on Ni-based Superalloys” (by Y. Zhang, B. A. Pint, J. A. Haynes, and I. G. Wright) has been submitted to Surface and Coatings Technology (for The International Conference on Metallurgical Coatings and Thin Films, May 2-6, 2005)

A Pt-enriched g+g' two-phase coating was applied to directionally-solidified Ni-based superalloy René 142 substrates with three different Hf levels (0.02, 0.76, and 1.37 wt.%). The coating was prepared by electroplating a thin layer of Pt (~7 microns) on the superalloy followed by a diffusion treatment of 2h in vacuum at 1150°C. The as-deposited coating exhibited a g+g' two-phase microstructure with a major composition of Ni-16Al-18Pt-7Cr-9Co (in at.%) along with some incorporation of refractory elements from the substrates. Cyclic oxidation tests at 1100°C in air indicated improved oxidation resistance of the René 142 alloys with the Pt-enriched g+g' coatings. In addition, the oxidation resistance of both uncoated and coated alloys was proportional to the Hf content in the substrate. Compared with the single-phase (Ni,Pt)Al coating, slightly higher mass gain and localized spallation were observed on the g+g' two-phase coating, which might be due to the segregation of refractory elements and high sulfur levels in these superalloy substrates.

(Note that g+g' stands for gamma + gamma prime.)

ISSUES

Report Prepared By	Date
Ying Zhang	04/19/05